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Effect of Different Potting Mixture on the Seedling Growth and Survival of *Albizia Gummifera* and *Cordia Africana*

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ABSTRACT
A potting mixture experiment was executed on *Cordia africana Lam.* and *Albizia gummifera* at Awassa tree nursery. Nine different soil mixture ratios and local top soil as control were compared using two prominent indigenous agroforestry tree species in order to study the effect of different potting substrate on the seedling growth performance and survival in nursery and field conditions. The soil mixture experiment was laid out in complete randomized design with three replications, The potting mixtures were T1 (6 part forest soil: 3 part compost: 1 sand), T2 (6 part forest soil: 2 part compost: 2 sand), T3 (6 part forest soil: 1 part compost: 3 sand), T4 (5 part forest soil: 4 part compost: 1 sand), T5 (5 part forest soil: 3 part compost: 2 sand), T6 (5 part forest soil: 2 part compost: 3 sand), T7 (4 part forest soil: 3 part compost: 3 sand), T8 (4 part forest soil: 4 part compost: 2 sand), T9 (3 part forest soil: 2 part compost: 1 sand), and T10 (local top soil or control). The results of the current investigation revealed that seedling growth and survival were high significantly ($P< 0.01$) affected by different potting mixtures. The tree seedling response was variable for soil mix, when potting mixtures with more compost were applied. The seedlings shoot and root length, number of primary and secondary roots, shoot and root dry matter, survival rate and sapling height were highly significant ($P< 0.01$) for both tree seedlings in T4. Hence, the soil substrate T4 (5:4:1) is recommended to *C. africana* and *A. gummifera* seedling production and their plantation success thereof.
Key words: potting mixture, growth, survival, seedling, *C. africana*, *A. gummifera*.

INTRODUCTION

In 1994, it has been estimated that the forest cover less than 2.7 % of the country land mass (EFAP, 1994). With the current annual loss of high forests, estimated at 150,000 – 200,000 ha, it has been projected that the area covered by high forest may be reduced to scattered minor stands of heavily disturbed forests in inaccessible parts of the country within a few decades. This fact shows the urgency of afforestation, reforestation and on farm tree planting is very paramount to balance the forest coverage.

Approximately 5.5 million hectares of forest tree species are planted annually in the tropics. This includes tree planted in agroforestry systems, for ornamental and cultural, soil protection, erosion control, and habitat improvement, for fuel wood, shelterbelt purposes and etc. An estimated 1.3 billion plants are thus needed yearly, and this figure is increasing steadily (Sehgal, 19960).

According the SNNPR bureau of agriculture report of 2000, the annual tree seedlings planting was 16.99 million in number whereas the survival rate of tree seedlings didn't exceed 65 %. This implies that the survival rate loss of planted seedlings was 35 % and 5.94 million seedlings in number. The estimated production cost per a seedling is 2.00 birr, so that the annual survival rate loss of the seedlings planting in terms of money is 11.88 million Ethiopian birr excluding the loss of planting pits expenditures. The first reason is lack of appropriate medium for production of standard seedlings at nursery level which could deliver high rate of survival at site conditions after out-planting.

In developing a medium for the production of polythene tube – grown seedlings, the function of the medium in seedling growth and survival must be understood and the standard medium should be determined to produce the most functional media for better plantation establishment. The standard or functional medium has some vital merits: produces vigorous seedlings having capability to establish them selves in field conditions; enhances the growth of seedlings which in turn reduces the nursery life span of the seedlings and raising cost thereof; increases the survival rate of seedlings at plantation site; determines the standard or proportion of potting mixture and thereby avoids the wastage of media ingredients and others.

Generally, tree growth is a function of the genetic potential of the species and environmental condition (Koslowsri et al., 1991). The environmental factor can be broadly categorized as the nursery environment and the field condition. These factors must be optimal to produce a health and vigorous seedlings, and among them,

the genes and the nursery environment determine to a large degree how a tree can survive (Jaenicke, 1999). Nurseries provide the means to control moisture, light and physical and chemical soil constituents in such a way as to produce healthy and uniform seedlings necessary for planting (Doran, 1997). Several factors can influence seedling growth in the nursery. But potting substrate is the most important factor from the nursery environment. This is because, first it is basically a plant's first food; secondly, it physically support a growing seedling and thirdly, it stores and supplies nutrients, water and air to the root system (Jaenicke, 1999).

Cordia africana Lam. belongs to the family of Boraginaceae. It grows as a forest remnant in cultivated areas; and in dry, moist and wet Weyna Dega agroclimatic zones in altitudes between 1600 and 2200 m.a.s.l. (Azane Bekele et al., 1993; von Breitenbach, 1963). *Albizia gummifera* is the most widespread tree in Ethiopia and usually quick growing. Leaves fasten the ripening of unique banana. The most appropriate shade tree of coffee plantations up to 2500 m.a.s.l. This tree may occur in Dry, Moist and Wet Weyna Dega agroecology regions from 1600 to 2500 m.a.s.l. (Azane Bekele et al., 1993). Some of its importance may include fuel wood, timber (general purpose, utensils, and mortar), water toughs, medicine (pods, roots, and bark), fodder (leaves), bee forage, soil conservation, nitrogen fixation, ornamental, shade and bee hives. .

Cordia africana has various uses as timber, food, medicine, fuel wood, fodder, soil conservation, shade, ornamental and mulch (Azene Bekele et al., 1993).C. africana is one of the most important indigenous tree species in the variety of items used by the communities. The density of wood of *Cordia africana* (0.41 gm/cm3, and other mechanical properties (WUARC, 1995), may be infer to some commonly used indigenous tree species such as A. adolfi-friederici, J. procera, Hagenia abyssinica and P. falactus. But, it has several uses and qualities that other species cannot afford. It can easily be curved out to make stool, chairs, beds, tables, doors and windows and can be used for internal constructions.

The purpose of a potting media is to satisfy the needs for good seedling growth with in the limited space of a polythene tubes/container and to prepare it for successful transplanting into the field. The media physically supports a growing seedling and both stores and supplies nutrients (and trace elements), water, and air to the root system. The better the media, the better will be development of a healthy, fibrous root system and subsequently a better quality seedling is produced which will survive after out planting and commence growth quickly. These features alone impart a financial value to the use of better potting media, which is unfortunately never measured. There are few natural materials with all the elements required for healthy root growth so potting media is usually blends of different elements. The larger-scale tree planting, which is becoming increasingly important in the SNNPR for both commercial as will as environmental reasons, requires healthy seedlings for success. A balanced soil substrate should be found prior to any field-planting program to ensure good root and shoot development for the planting stock. But appropriate potting mixtures for use was lacking.

MATERIALS AND METHODS

Study site description

Location and climate

The potting mixture experiment was conducted at the tree seedling nursery of Awassa Agricultural Research Center. The nursery site is found under climate with a mean annual rainfall of about 1051mm and mean temperature of (maximum 27.1^0c, minimum12^0 c) based on 5 years of metrological data of the research station. The Awassa meteorological station is located at 1750 m.a.s.l. The soil type of Awassa research station is belongs to Ando sol.

Potting mixture preparation

Compost was prepared from easily available materials in the area such as Ficus vasta leaves and litter fall of fruit trees (Avocado and Guava) which is affordable even for a marginal farmers in the study Region. The equal amount of leaves of all organic resources were toughly mixed and used for compost. Matured compost was dried, crushed and sieved in advance of making potting mixtures of forest soil, sand and compost. Forest soil obtained from remnant natural forests of Wondo-Genet College of forestry. The potting mixture of forest soil, compost and sand in turn which have been made up of the following different proportions/ratios: T1 (6 part forest soil: 3 part compost: 1 part sand), T2 (6 part forest soil: 2 part compost: 2 part sand), T3 (6 part forest soil: 1 part compost: 3 part sand), T4 (5 part forest soil: 4 part compost: 1 part sand), T5 (5 part forest soil: 3 part compost: 2 part sand), T6 (5 part forest soil: 2 part compost: 3 part sand), T7 (4 part

forest soil: 3 part compost: 3 part sand), T8 (4 part forest soil: 4 part compost: 2 part sand), T9 (2 part forest soil: 2 part compost:1 part sand), and T10 or control (pure local top soil of the tree nursery). Polythene tubes of 15 cm long and 8 cm wide are used for potting purpose.

Seedling production

The tree seed of *Albizia gummifera* and *Cordia africana* were purchased from the National Tree Seed Project of Forestry Research Center, Addis Ababa-Ethiopia. The seedlings of the experimental tree species raised in polythene tubes at Awassa forest nursery.

Experimental design

Potting mixture experiment was laid out in Complete Randomized Block Design (CRBD) with three replications during 2003 - 2004 for consecutive two years at Awassa forest tree nursery. Nine potting mixtures of forest soil, compost and sand were used. Which have been employed as treatments, and compared with control (pure local top soil).

Out planting

The tree seedlings were out planted when they reached plant able size, in the field already prepared for testing of the survival rate and growth performance of the seedlings after out planting in the natural environmental conditions. Planting pits were dung at 2 m x 2 m spacing two months prior to out planting.

Data collection and analysis

Data on seedling shoot and root growth were collected prior to out planting in the field conditions, similarly shoot and root dry matter data has been recorded after drying of the seedlings in the oven for 48 hours till constant dry weight was attained.
Survival rate and sapling height data were colleted after a year of transplanting, leaving the boundary rows. The whole parameters have been taken on average basis while considering the number of trees in the experimental plot. Data for shoot and root length, primary and secondary root numbers, shoot and root dry matter weight, survival rate and sapling height were tested for significant differences, using analysis of variance for complete randomized design, and then further analyzed using least significance difference test (Table 2, 3, 4 and 5).

.RESULTS AND DISCUSSIONS

Top soil analysis

Composite soil sample was collected from the experimental site prior to planting. Results indicated that the soil belong to textural class and has slightly alkaline pH with exchangeable acidity (Table 1) Electrical conductivity, 0.161 ds\m, values indicated a soil free from salt. Cation exchange capacity (CEC) and organic matter content values were medium. However, base saturation percentage value indicated slightly above medium rating. Thus the fertility status of the soil was high as described in Weeraratna and Verima (1992).

The ratio of Ca++ to Mg++ was greater than five and K+ to Mg higher than two. The medium CEC value might be due to combined effect of medium organic carbon and low clay content. This indicated that the soil had fairly good potential in retaining nutrients and might show response to applied nutrient. Total nitrogen was moderate. The C: N ratio was 10 depicting that soil favors occurrence of net mineralization 0 and little immobilization of nutrients. The available phosphorus in the experimental soil was rated high (Table,1)..Hence, the soil was appropriate for tree seedling growth and development.

Table1.Mean value of physico-chemical properties of top surface (0-25 cm) soil at Awassa agricultural research center.

PARAMETERS	Mean value
Sand (%)	45
Silt (%)	25
Clay (%)	30
Texture class	loam
Soil pH water (1:2.5)	7.7
Soil pH KCI (1:2.5)	6.4
Electrical conductivity (ds/m)	0.161
Exchangeable K (Cmol/kg)	1.07
Exchangeable Na (Cmol/kg)	4.06
Exchangeable Ca (Cmol/kg)	8.26
Exchangeable Mg (Cmol /kg)	1.98
Total exchangeable bases (Cmol/kg)	15.37
Cation exchange capacity (Cmol/kg)	23.30
Base saturation(%)	66
Organic carbon (%)	1.25
Organic matter (%)	2.15
Total Nitrogen (%)	0.129
C:N ratio	10.0
Available p (mg/kg)	38.16

Seedling growth

The shoot and root growth of the seedlings of *Cordia africana* and *Albizia gummifera* were significantly affected by different potting mixtures or nursery media (Table 2, 3,4 and 5). The shoot and root growth of the seedling were minimum in T10 (pure local top soil or control) for both tree species, which could be due to absence of compost/organic matter and forest soil in soil substrate. The result is in line with Abebe (2000) and Husnia (1995), who also reported that different soil mixtures affected the growth of shoot and root differently. The potting mixture experiment results revealed that the shoot and root length as well as primary and secondary root numbers were found maximum in T4 (Table 2 and 3). The right proportion of potting mixture could produces or raises a healthy and vigorous seedling which being reach in very short period of time for planting. The best seedling growing media should contain adequate amount of compost in order to provide fast, vigor and health seedlings for tree planting of all reasons. This experiment has justified these facts of nursery growing media techniques.

Table 2. Mean growth value of three months old C. africana seedlings as influenced by nursery media

Potting mixture (F:C:S)	Shoot length (cm)	Root length (cm)	Primary roots (No.)	Secondary roots (No.)
T1 (6:3:1)	35.667	20.600	44.000	20.333
T2 (6:2:2)	32.300	17.400	35.000	15.333
T3 (6:1:3)	26.533 ns	14.133	30.000	13.000
T4 (5:4:1)	38.333**	22.333	47.000	22.667
T5 (5:3:2)	34.300	18.900	39.000	17.667
T6 (5:2:3)	27.433*	15.030	32.333	13.333
T7 (4:3:3)	30.267	15.700	34.000	14.333
T8 (4:4:2)	34.600	19.600	40.667	19.000
T9 (3:2:1)	33.000	17.633	36.667	16.333
T10 (Control)	25.476	13.633	28.000	12.000
Mean	31.791	17.496	36.666	16.399
LSD (0.05)	1.847	1.916	1.959	1.677
LSD (0.05)	2.655	2.755	2.816	2.411
CV (%)	2.066	5.591	2.727	5.220

F:C:S = Forest soil:Compost:Sand **highly significant *significant ns = non significant

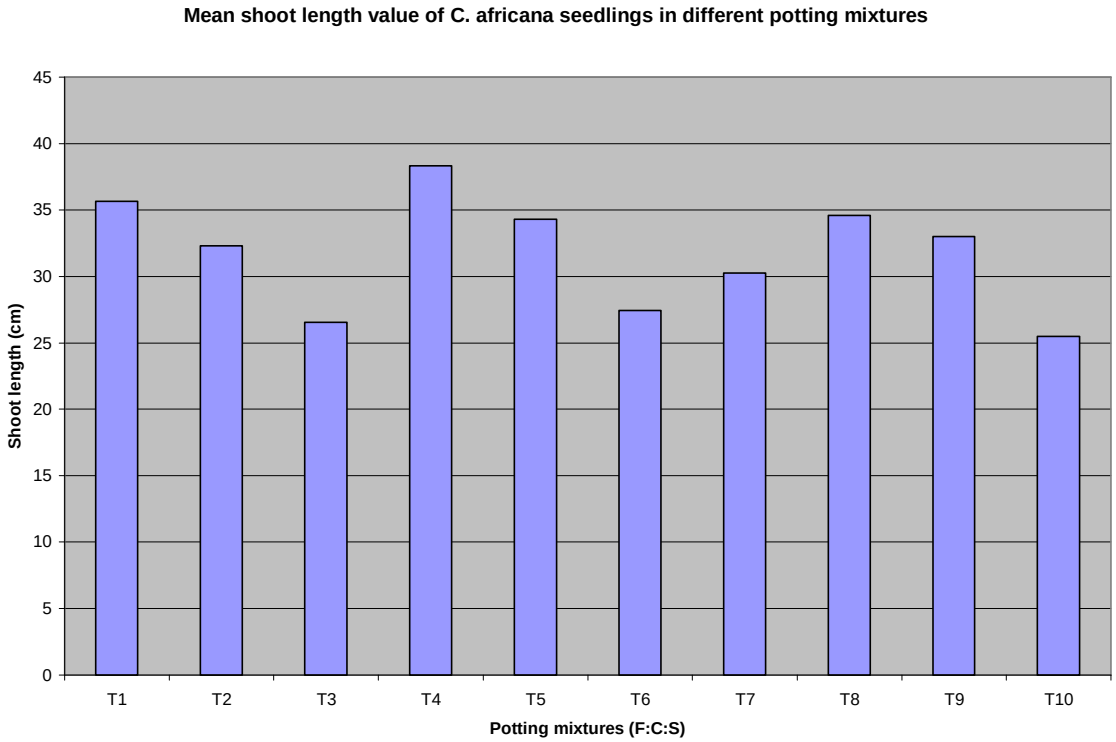
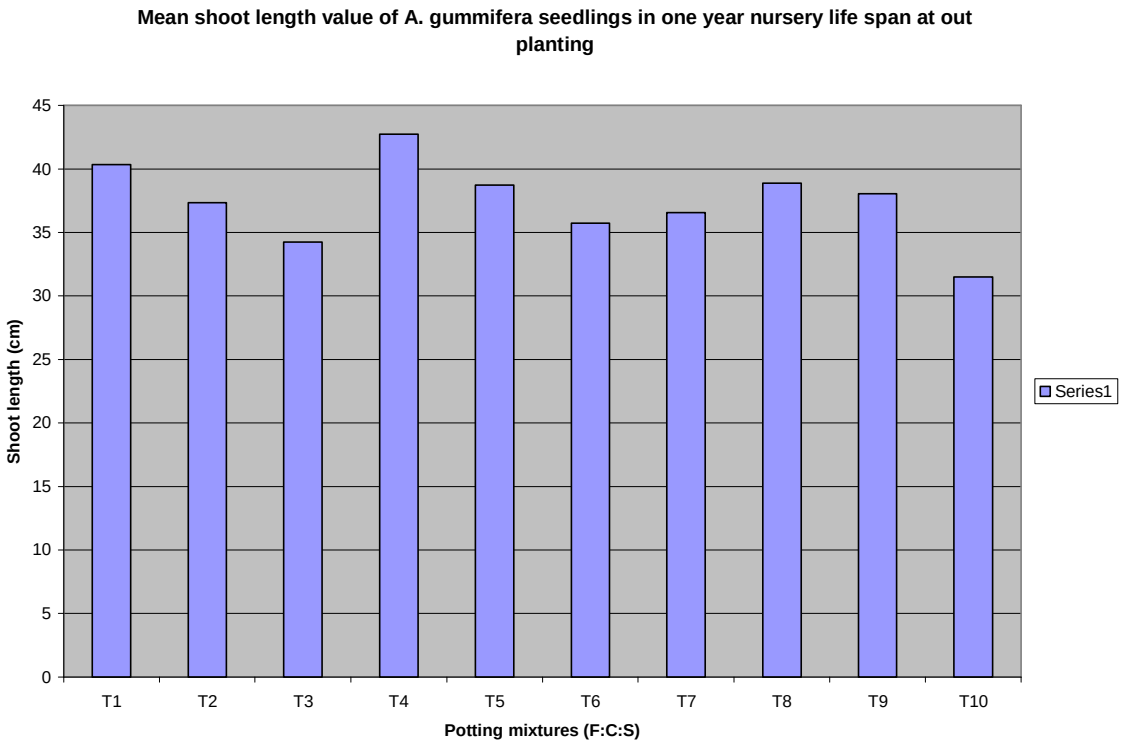


Table 3.. Mean growth value of one year old *Albizia gummifera* seedlings as influenced by growing media in the nursery

Potting mixture (F:C:S)	Shoot length (cm)	Root length (cm)	Primary roots (No.)	Secondary roots (No.)
T1 (6:3:1)	40.333	17.200	30.667	11.667
T2 (6:2:2)	37.333	12.233	26.000	8.333
T3 (6:1:3)	34.233	10.300	21.000	6.333
T4 (5:4:1)	42.733	18.100	31.667	12.667
T5 (5:3:2)	38.733	14.967	28.000	9.667
T6 (5:2:3)	35.733	10.900	23.333	7.000
T7 (4:3:3)	36.566	11.333	25.000	7.667
T8 (4:4:2)	38.866	15.633	29.333	10.667
T9 (3:2:1)	38.033	13.200	27.667	9.000
T10 (Control)	31.500	10.100	19.000	6.000
Mean	37.406	13.396	26.166	8.900
LSD (0.05)	1.301	1.211	1.824	1.430
LSD (0.05)	1.870	1.741	2.622	2.056
CV (%)	0.519	4.619	3.558	8.203

F:C:S = Forest soil:Compost:Sand **highly significant *significant ns = non significant



Shoot and root dry matter

Shoot and root dry matter weight of the seedlings was significant for C.africana and A.gummifera tree seedlings. The highest shoot & root dry matter weight per a seedling was found in T4 (5 part forest soil: 4 part compost: 1 part sand mixture) for both tested tree species (Table 4 and 5). Shoot and root dry matter were lower in T10 and T3 which, perhaps, due to the absence of forest soil and compost in the former and inadequate amount of compost and excess sand in the later, respectively.

Survival rate

Seedling survival rate was significantly affected by difference in potting mixture for both tree species (Table 4 and 5). The survival rate of C. africana (98.333 %) and A. gummifera (95.000 %) was significantly higher in T4 than that of in T10. The seedlings survival percent was 3 % and 5 % higher in T4 than in T9 (ratio used in Awassa Zuria Woreda in Sidama Zone) for C. africana and A. gummifera tree species..

Sapling height

The tree species bigger than seedling and smaller than tree is termed as sapling. Sapling height of both tested tree species was significantly higher in T4 (Table 4 and 5).The sapling height difference between C. africana and A. gummifera was their own natural genetic variation of the tree species it is not due to soil mix. In relatively speaking C. africana is fast growing and A. gummifera is slow growing tree species of mid to high altitude areas in SNNPR.

Table 4. Mean growth values of C. africana seedlings at three months nursery life span and their survival rate

Potting mixture (F:C:S)	SDM (gm/seedling)	RDM (gm/seedling)	Survival rate (%)	Sapling height (cm)
T1 (6:3:1)	24.461	14.874	96.667	167.000
T2 (6:2:2)	20.668	12.170	95.000	147.000
T3 (6:1:3)	17.740	10.988	94.333	140.000
T4 (5:4:1)	26.489	16.341	98.333	171.000
T5 (5:3:2)	22.275	13.199	95.333	154.000
T6 (5:2:3)	18.498	11.642	94.667	142.000
T7 (4:3:3)	20.311	12.149	95.000	145.000
T8 (4:4:2)	23.885	14.268	95.667	161.000
T9 (3:2:1)	21.128	12.552	95.000	150.000
T10 (Control)	16.405	10.452	93.333	138.000
Mean	21.186	12.864	95.333	151.500
LSD (0.05)	1.667	1.016	1.517	2.25
LSD (0.01)	2.396	1.460	2.181	3.21
CV (%)	4.916	4.032	0.810	0.75

SDM = shoot dry matter RDM = root dry matter

Figure 3. Mean survival rate of C. africana sapling in one year of out planting

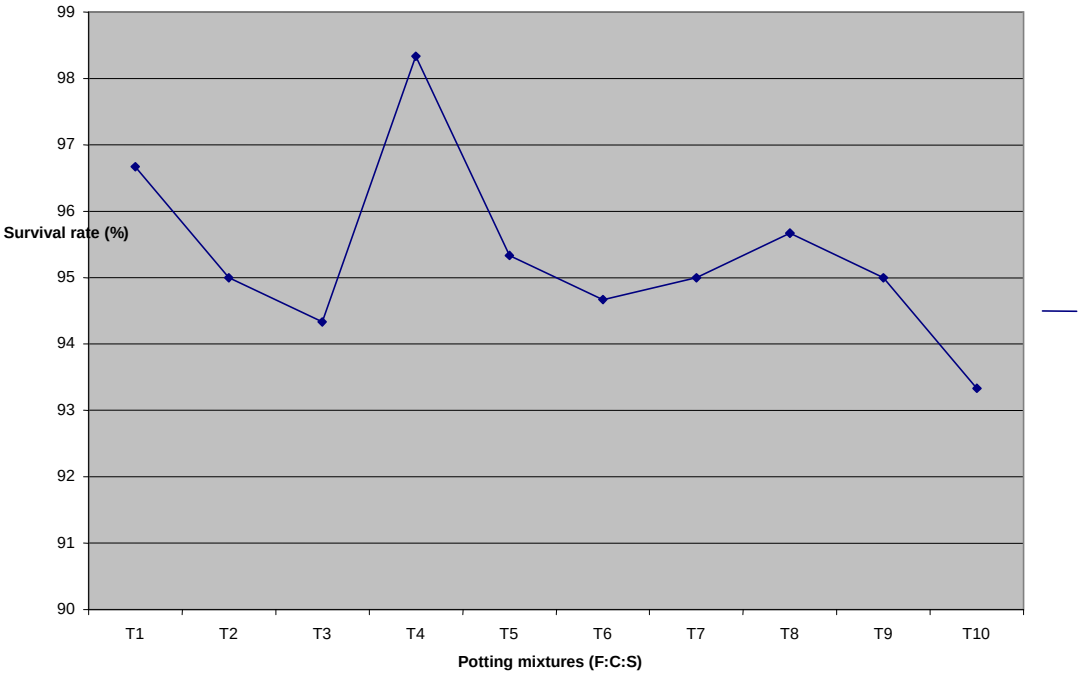
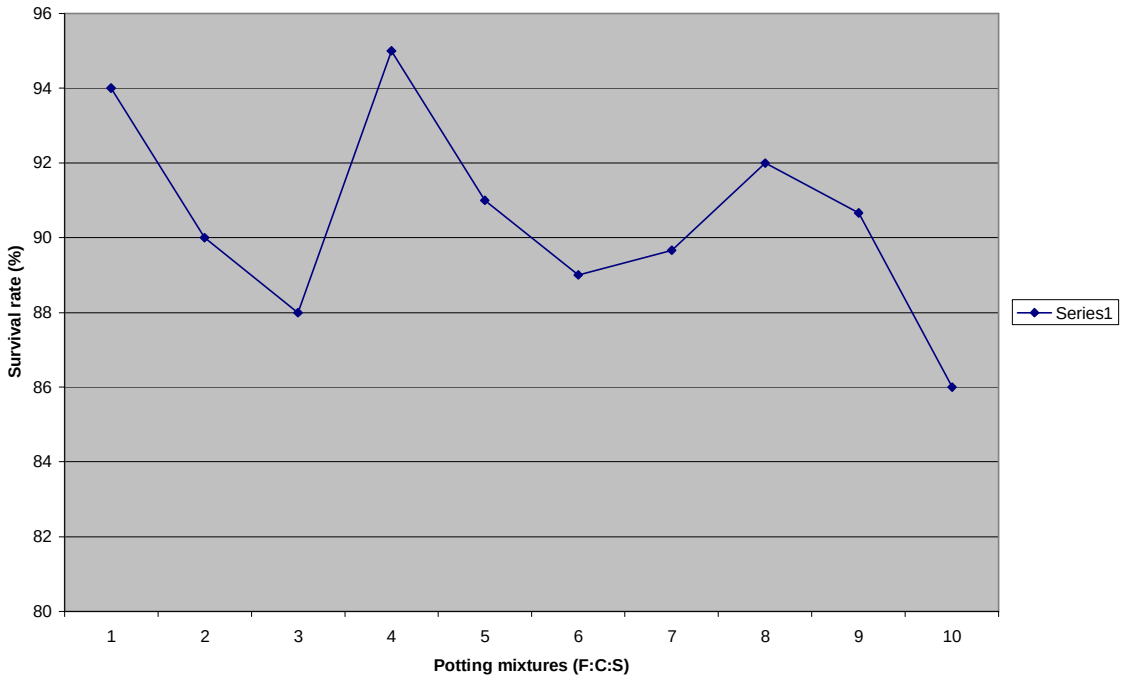


Table 5. Mean growth values of A. gummifera seedlings at one year nursery life span and their survival rate

Potting mixture (F:C:S)	SDM (gm/seedling)	RDM (gm/seedling)	Survival rate (%)	Sapling height (cm)
T1 (6:3:1)	12.315	7.446	94.000	118.230
T2 (6:2:2)	9.871	4.072	90.000	103.930
T3 (6:1:3)	6.048	3.033	88.000	89.160
T4 (5:4:1)	12.998	7.502	95.000	120.420
T5 (5:3:2)	11.177	5.596	91.000	115.300
T6 (5:2:3)	7.963	3.284	89.000	93.460
T7 (4:3:3)	8.247	3.658	89.667	98.400
T8 (4:4:2)	12.030	6.035	92.000	116.000
T9 (3:2:1)	10.606	4.752	90.667	108.130
T10 (Control)	5.821	2.981	86.000	82.333
Mean	9.708	4.836	90.533	104.536
LSD (0.05)	0.817	0.643	1.824	1..805
LSD (0.01)	1.175	0.925	2.622	2.594
CV (%)	4.315	6.843	1.028	0.881

SDM = shoot dry matter RDM = root dry matter

Figure 4. Mean survival rate of A. gummifera in one year of out planting



CONCLUSION AND RECOMMENDATION

The shoot and root growth, number of primary and secondary roots, shoot and root dry matter weight and survival rate of seedlings were significantly influenced by potting mixture (soil substrate). The results revealed that the growth performance of the seedlings was increased when the higher amount/part of compost was used in the nursery soil substrate. Hence, it is recommended to use the T4 (5 part forest soil: 4 part compost: 1 part sand) as a potting mixture for *Cordia africana* and *Albizia gummifera* tree species. .

REFERENCES

Abebe, Y., Diriba, B. and Benti, T. 2000. Determination of optimum nursery soil mixture and pot size for pot size for E. amaldulensis and A. mearnsii at Bako. Cof. Proc. Ethiopia society of soil sciences. pp. 157-166.

Azene Bekele-Tesemma, Ann Birnie, and B. Tengnas, 1993. Useful trees and shrubs for Ethiopia. Technical Hand Book. No. 5, Regional Soil Conservation Unit/SIDA, Nairobi, Kenya. pp. 172-173.

Doran, J.C. 1997. Seed, nursery practice and management. In. J.C. Doran and J.W. Tum bull (eds), Australian trees and shrubs: Land rehabilitation and farm tree planting in the tropics. Australian Center of International Agricultural Reseach, Australia.

EFAP, 1994. Ethiopian Forestry Action Plan country document.

Jaenicke, H. 1999. Potting substrate. What do seedling needs to grow well? Agroforestry today. 11: 31-33

Koslowski, T. T. Kramer E.J. and S.G. Pallardy. 1991. The physial ecology of woody plants, Aademi press, Incude USA.

Negarit Gazetta. 1994. Forestry Conservation, Development and Utilization Proclamation of the Federal Democratic Repobilic of Ethiopia, proclamation No. 94/1994, Addis Ababa.

Sehgal, R.N. 1996. Lecture in proc. summer institute on " Advances in development and management of agroforestry systems" June 17 to July 6, 1996 at college of forestry, UHF, Nauni. pp. 252-268.

von Breitenbach, F. 1963. The indiganous trees of Ethiopia. Second edition, Ethiopian Forestry Association, Addis Ababa. pp. 281-284.

Wood Utilization and Research Center (WUARC). 1995. Commercial timbers of Ethiopia. Technical Bulletin No. 2, Ministry of Natural Resources Development and Environmental Protection, Addis Ababa. pp. 89-92.